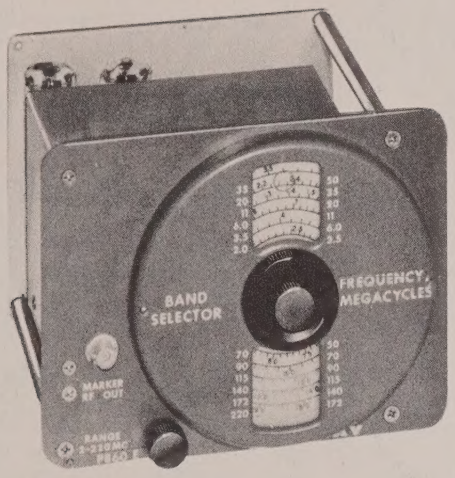
INSTRUCTION MANUAL
ISSUE B

MAY 1964

INSTRUMENT CENTER




# SWEEPING OSCILLATOR

# PLUG-IN UNIT

# MODEL P-860E

**POLICY COVERING REPRODUCTION AND USE OF TECHNICAL DATA**

Data contained in this manual is copyrighted by Kay Electric Company and is furnished solely for the purpose of providing instructions for operation and maintenance of the apparatus described herein. Said data shall not be used by the purchaser or the government for promotional procurement, development, or manufacturing purposes, nor shall the data be reproduced or disclosed without permission from Kay Electric Company. In the event of resale of the apparatus to the government by the purchaser, the purchaser shall notify the government of the limited right to use said data.

Copyright, Kay Electric Co., 1964

KAY ELECTRIC COMPANY
PINE BROOK, N.J.
CApital 6-4000

# TABLE OF CONTENTS


| Paragraph | | Page |
|---|---|---|
| | **SECTION I, GENERAL INFORMATION** | |
| 1-1 | Introduction | 1 |
| 1-2 | Shipping Damage | 1 |
| 1-3 | Specifications | 1 |
| | **SECTION II, OPERATION** | |
| 2-1 | Introduction | 2 |
| 2-2 | Controls and Terminals | 2 |
| 2-3 | Operation | 2 |
| | **SECTION III, CIRCUIT DESCRIPTION** | |
| 3-1 | General Description | 3 |
| | **SECTION IV, MAINTENANCE** | |
| 4-1 | Introduction | 4 |
| 4-2 | Trouble-Shooting Suggestions | 5 |
| 4-3 | Adjustment of Circuit Variables | 5 |
| | **SECTION V, LISTING OF REPLACEABLE PARTS** | |
| 5-1 | Introduction | 11 |
| 5-2 | Listing of Replaceable Parts, P-860E | 11 |


# LIST OF ILLUSTRATIONS


| Figure | | Page |
|---|---|---|
| 3-1 | Simplified Block Diagram | 4 |
| 4-1 | Interconnection of Equipment for Alignment Procedure | 6 |
| 4-2 | Detector-Mixer Circuit | 6 |
| 4-3 | Top View of Chassis | 8 |
| 4-4 | Bottom View of Chassis | 9 |
| 5-1 | Schematic, P-860E, C-8479A | 12 |

## I-1 INTRODUCTION.

The P-860E sweep plug-in is designed for use with Kay sweeping oscillator units, such as the Marka-Sweep Model Pi and Vari-Sweep Model 860-E. The frequency spectrum from 2 to 220 mc is covered in 12 switched, overlapping bands. The sweeping output is fundamental frequency and continuously tunable across this range. Amplitude is held flat within ±0.5 db by fast-acting agc. Sweep width is adjustable up to 60% of center frequency below 50 mc, and up to 30 mc wide above 50 mc. Amplitude is continuously variable to a maximum of 1 volt rms across 70 ohms (50 ohms, if ordered).

A Marker RF Out jack on the front panel provides a means of coupling out a tapped-down swept r-f voltage to the marker plug-in, or to an external marker generator, such as Kay Vari-Marker Model F. The Model F provides up to 40 crystal-positioned, pulse-type frequency markers. When the P-860E sweep head is used with the Model Pi rack, markers may be developed by using the PM-932 marker head. Up to 30 markers in six groups covering 2 to 220 mc are provided.

Oscillator band switching turret consists of individual molded Teflon sections with solid silver contacts. The tuning element for each band is contained in a separate plug-in module which may be removed for inspection or replacement. For particularly narrow sweep or other special applications, additional special modules at specific frequencies may be ordered.

Power for the P-860E sweep head and all driving signals are furnished by the basic rack unit.

## I-2 SHIPPING DAMAGE.

As soon as the Model P-860E Sweeping Oscillator Plug-in is received, it should be visually inspected to determine that it was not damaged during shipment. A careful check of packing case contents should be made to insure removal of all items shipped. Shortage or damage should be reported immediately to the Carrier and Kay Electric Company, or its representative in the area.

Equipment Supplied. The Model P-860E is shipped completely assembled and ready for installation in a compatible basic rack unit. Other auxiliary equipment and interconnecting cables referenced in these instructions are not furnished.

## I-3 SPECIFICATIONS.

Frequency Range: 2 to 220 mc in 12 bands.

| | | |
|---|---|---|
| Band 1 | 2 to 3.5 mc | Sweep width continuously variable to 60% of center frequency. |
| Band 2 | 3.5 to 6 mc | |
| Band 3 | 6 to 11 mc | |
| Band 4 | 11 to 20 mc | |
| Band 5 | 20 to 35 mc | |
| Band 6 | 35 to 50 mc | |
| Band 7 | 50 to 70 mc | Sweep width continuously variable to at least 30 mc. |
| Band 8 | 70 to 90 mc | |
| Band 9 | 90 to 115 mc | |
| Band 10 | 115 to 140 mc | |
| Band 11 | 140 to 172 mc | |
| Band 12 | 172 to 220 mc | |

Output: 1 volt rms

Flatness: ±0.5 db over each band.

Power Input: All driving signals and power are furnished by the basic rack unit.

Dimensions: 6"h by 7½"w by 10"d over-all.

Weight: 6 lbs.

## 2-1 INTRODUCTION.

General operating instructions are furnished in the instruction manual provided with the basic rack unit(s) in which this sweep plug-in head may be used. Specific identification and function of only those controls and terminals physically located on the plug-in head are discussed here. Since these controls and terminals have a direct relationship to those on the basic rack, both manuals should be referred to.

Installation of P-860E sweep plug-in in the rack unit is accomplished by pushing the plug-in into the receiving well as far as it will go. To lock the plug-in in place, turn the locking screw clockwise until it is tight. The plug-in may be removed from the rack unit by turning the locking screw counterclockwise to release it from the rack, and pulling the plug-in free.

## 2-2 CONTROLS AND TERMINALS.

| CONTROL | POSITION | FUNCTION |
|---|---|---|
| Band Selector Switch, S-1 | 12 positions | Used to select the r-f frequency range. |
| Center Frequency control, C-7, C-8. | Variable | Used to adjust center frequency of swept output, or output frequency when instrument is operated in the c-w mode. |
| Linearity Adjust pot., R-10 (int.). | Variable | Used to adjust frequency deviation linearity. Located on top of chassis. |
| Meter Adj. pot., R-1 (int.). | Variable | Used to calibrate the output meter. |

| TERMINALS | FUNCTION |
|---|---|
| Marker RF Out jack, J-1. | A tapped-down r-f swept voltage is available here and used to drive the marker plug-in, or an external marker generator. |
| RF Out jack J-2 | Swept r-f is available here and is normally patched to the attenuator input in the rack unit. Located at rear of chassis. |

## 2-3 OPERATION.

It is assumed that the P-860E sweep plug-in head is installed in its receptacle in the basic rack, and connections provided between the associated equipment as described in the instruction manual provided with the basic rack unit. For most applications, the interconnections illustrated in the instruction manual furnished with the basic rack unit will be correct (Fig. 1-1, Marka-Sweep Model Pi; Fig. 2-1, Vari-Sweep 860-E manual).

The Band Selector switch on the P-860E head is used to select the frequency range to be swept (or the range for c-w operation) depending on the selection made with the Sweep Selector switch on the rack unit.

The Frequency (in) Megacycles control (center concentric control) is used to change sweep center frequency (or c-w frequency) within the range selected by the Band Selector. The sweep Width control on the rack unit is used to establish the width of the sweep, i.e., the frequency deviation above and below the selected center frequency.

The Marker RF Out jack provides access to a portion of the swept rf, which may be used with external equipment to develop frequency markers. There is no requirement for a connection between this jack and Model 860-E rack unit; however, when the Model Pi rack is used, a coaxial patch cord should be connected between the Marker RF Out jack and the Marker RF In jack on the marker plug-in in use.

Additional operating instructions are furnished in the manuals furnished with the basic rack units. Basic operation, however, is similar in all cases, viz.,

a) Select the operating mode with the Sweep Selector- Line Lock, Variable 1-5, 5-25 cps rep rate, Manual, or CW.

b) Select the frequency range with the Band Selector.

c) Select the desired center frequency by adjusting the center concentric control on the sweep head.

d) Establish an appropriate sweep width by adjusting the Sweep Width control.

e) Adjust the RF Level and/or step attenuator for a convenient output amplitude.

When the Sweep Selector is set for manual sweep, the Manual Sweep control performs the function accomplished by the sweep generating circuits in the line-lock and variable sweep modes.

When operating in the c-w mode, the sweep generating circuits are inactive and the Band Selector, and its concentric tuning control, determine the frequency of the c-w output.

Depending on the characteristics of the basic rack unit, additional variable sweep rates and operating modes may be available. Similarly, the c-w mode may or may not be available.

## SECTION III, CIRCUIT DESCRIPTION

### 3-1 INTRODUCTION.

The basic circuits of the P-860E sweep plug-in head consist of a sawtooth amplifier (V-1); r-f oscillator (V-2, V-3); and agc detector (D-4, D-5). All driving signals and operating power for the sweep head are furnished by the rack unit in which the head is used. Fig. 3-1.

The sawtooth voltage developed by the sweep generating circuits in the rack unit is amplified by V-1. This sawtooth voltage is then used to vary the current through saturable reactor L-3, since it is in series with the plate supply for V-1. The inductance of the oscillator tank coils (L-4 thru L-15) changes in accordance with the current through L-3, thus changing the frequency of the r-f oscillator. Band changing is accomplished by Band Selector switch S-1, and tuning within each band by capacitors C-7, C-8.

The rf output signal from the sweep plug-in is sinusoidal and varies in frequency (swept) as determined by the current through V-1, and the instantaneous inductance of the oscillator tank coils. Output is taken from pick-off loops (B) and made available at the output jack J-2.

Automatic gain control is achieved by taking a sample of the output signal and coupling it to a voltage-doubler detector circuit employing diodes D-4, D-5. The resultant rectified voltage is applied to the agc amplifier and control stage in the rack. The agc'd voltage is used as the plate potential for the r-f oscillator (V-2, V-3) to maintain flat output.

In manual sweep mode, sweep generating circuits are inactive, and current through saturable reactor L-3 is varied in accordance with the position of the Manual Sweep control (on rack unit) due to the d-c coupling. Frequency range of

the manual sweep is determined by the sweep width established by the Sweep Width control (on rack unit), the frequency range selected by the Band Selector, and center frequency established by the position of the Frequency (in) Megacycles tuning control.

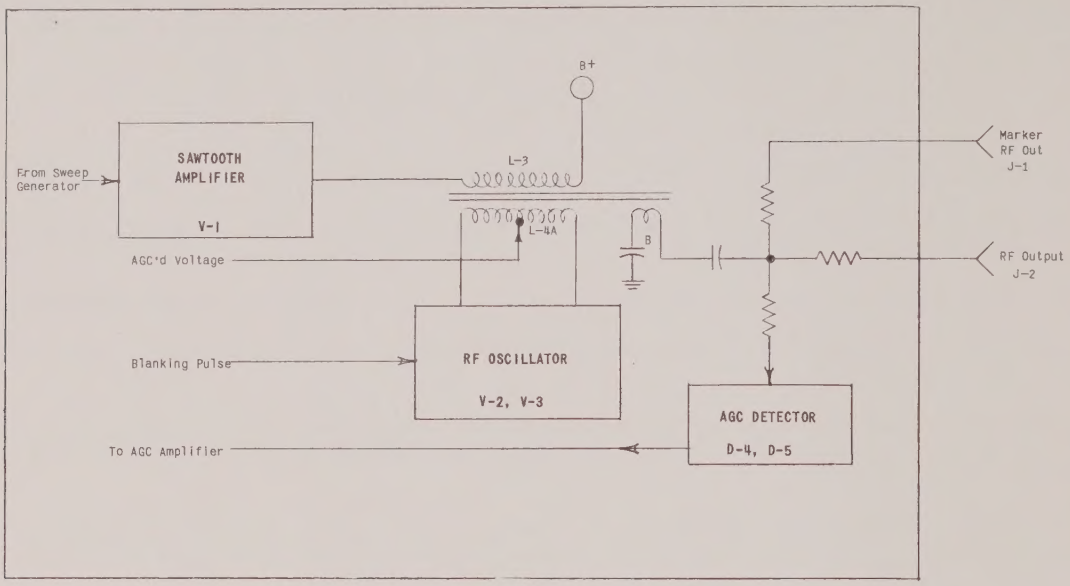



Fig. 3-1 Simplified block diagram, Model P-860E sweep oscillator plug-in.

During c-w operation, the sweep generating circuits are inactive and a steady current flows through L-3 and V-1, permitting the oscillator (V-2, V-3) to oscillate at a frequency determined by the tank coil in the plate circuit and the setting of the Frequency (in) Megacycles tuning control.

## SECTION IV, MAINTENANCE

### 4-1 INTRODUCTION.

Maintenance instructions furnished here should be used in conjunction with those in the manual provided with the basic rack unit. The P-860E sweep plug-in should be operated removed from the rack in order to check voltages. This can be done by using a multiconductor cable, Extension Cable, Kay P/N 8085 @ $14.95, and a single conductor coaxial cable, Kay P/N 8084 @ $4.95.

If instrument performance seems defective in any respect, first determine that the cause is not in the associated equipment, or in the connections between equipment. Check the B+ voltage, as instructed in the manual furnished with the basic rack unit. Reset B+ voltage if necessary. Typical voltages at check points, as well as waveforms, are shown on the schematic, and in Table 4-1 of these instructions. Figures 4-3 and 4-4 show location of major components.

## 4-2 TROUBLE-SHOOTING SUGGESTIONS.

| SYMPTOM | POSSIBLE CAUSE |
|---|---|
| No r-f output | a. Defective V-1 and/or V-2, V-3.<br>b. Check associated circuitry. |
| Low (or high) r-f output. | a. Defective agc, check V-3, V-4 in rack.<br>b. Check D-4, D-5.<br>c. Check V-2, V-3 oscillator tubes. |
| Poor sweep linearity. | a. Defective D-2, D-3.<br>b. Check adjustment of R-10.<br>c. If nonlinear on one band only, check appropriate linearity resistor, R-23 thru R-34. |
| Improper sweep width. | a. Defective V-2 in rack.<br>b. If improper sweep width on one band only, check appropriate sweep width resistor, R-11 thru R-22. |

TABLE 4-1, VOLTAGE MEASUREMENTS

| CIRCUIT SYMBOL | TUBE TYPE | PIN 1 | PIN 2 | PIN 3 | PIN 4 | PIN 5 | PIN 6 | PIN 7 | PIN 8 | PIN 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| V-1 | 6CL6 | 22 | 14 | 170 | Fil | Fil | 235 | 22 | 170 | 14 |
| V-2 & V-3 | 5718 | -6* | --- | Gnd | --- | Gnd | Fil | --- | 65 to 140** | --- |

Conditions: Sweep Selector switch in C-W position.
* Measured with 47K isolating resistor in series with VTVM probe.
** Depending on position of Band Selector.

## 4-3 ADJUSTMENT OF CIRCUIT VARIABLES.

To perform the maintenance operations described here, it will also be necessary to refer to the maintenance section in the manual furnished with the rack unit.

A. Suggested Equipment.

Cathode-ray Oscilloscope
Detector-Mixer (See Fig. 4-2).
C-W Generator, 2 - 220 mc.

B. Interconnection of Equipment.

1. Operate the P-860E sweep head removed from the rack unit, by using the extension cables referenced in Section 4-1. Apply power to the rack unit and allow a few minutes warm-up time to stabilize the circuits.

2. Check $B^+$ voltage as instructed in the manual for the rack unit and reset, if necessary, to the specified voltage.

3. Interconnect the equipment as shown in Fig. 4-1, using the detector-mixer shown in Fig. 4-2.

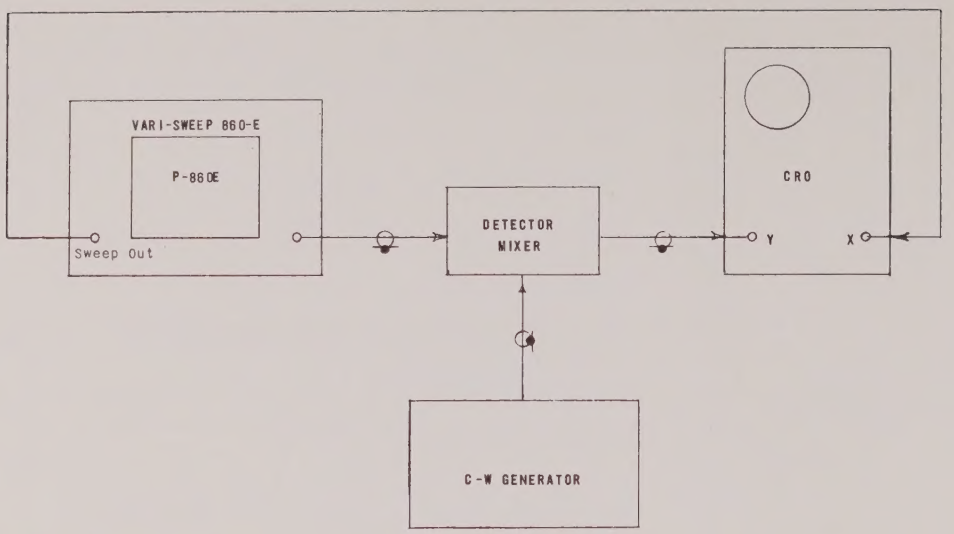



Fig. 4-1 Interconnection of equipment for the alignment procedure.

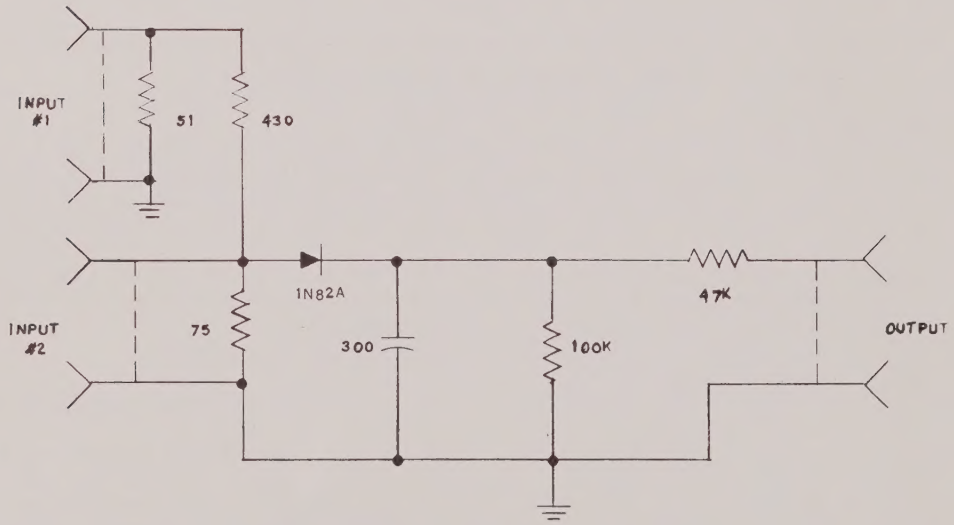



Fig. 4-2 Detector-Mixer Circuit. The detector should be assembled in a small metal case, keeping all leads short, consistent with high-frequency wiring techniques.

Lin Adj control R-10 provides a means of adjusting linearity of the swept frequency. Since the gain of the sweep amplifier may vary with individual tubes, sweep linearity should be checked if V-1 is replaced.

Sweep centering is established by setting of Center Frequency control C-7, C-8 and the inductance of the oscillator tank coil (L-4A thru L-15A) switched into the circuit by Band Selector switch S-1.

Sweep width is established by factory-selected resistors R-11 thru R-22 and the setting of the Sweep Width control on the rack unit.

C. Check Frequency Ranges (2 - 220 mc, 12 bands), Sweep Width, and Linearity.

1. Check low frequency narrow sweep.

   a. Set Band Selector to lowest frequency range (2 - 3.5 mc).

   b. Set Sweep Selector to CW position.

   c. Set Center Frequency control to lowest frequency marked on dial cover (2 mc).

   d. Set c-w generator for 2-mc output frequency. A zero beat should appear on screen at approximately 2 mc.

   e. Set Center Frequency control to upper specified frequency for the low band, and set c-w generator to the frequency shown on the dial cover. A zero beat should appear on screen at this frequency (3.5 mc).

If center frequency for either the lower or upper limits of the low band require adjustment, the frequency can be raised or lowered by spreading or compressing the coil turns (L-4 thru L-15A). Spreading the turns will reduce the inductance (raise the frequency), or conversely, compressing the turns will increase the inductance and lower the frequency. If this adjustment is undertaken, caution should be exercised to avoid damage to the coil turns and the ferrite rods.

2. Check sweep centering.

   a. Set Center Frequency control to lower specified frequency for the lowest frequency range (2 mc).

   b. Set Sweep Selector to Line Lock.

   c. Set Sweep Width control fully counterclockwise.

   d. Set c-w generator to approximately 2 mc.

   e. Turn Sweep Width control fully clockwise. The birdie should appear in the center of the trace. If birdie appears more than ±15% from center of trace, check Zener diode D-1.

3. Check sweep width.

   a. Adjust the frequency of the c-w input to the detector-mixer to move the birdie to the extreme left of the display. Record this frequency.

   b. Adjust the c-w frequency to move the birdie to the extreme right of the display. Record this frequency.

   c. Subtract the lower frequency from the higher. The result is sweep width in megacycles, and should be sufficiently wide to meet specifications (1.2 mc). (60% of center frequency, see Specifications Section 1-3.) If necessary, select a new value for the low-band sweep width resistor (R-11). Decreasing the value increases sweep width.

4. Check linearity.

   a. Linearity can be checked by changing the c-w frequency to move the birdie across the display in equal frequency increments. The swept range should be linear across the center 80% of sweep width. If not, adjust Lin Adj control R-10, which sets linearity for all bands. If any one band is nonlinear, select a new value for the appropriate linearity resistor (R-23 thru R-34).

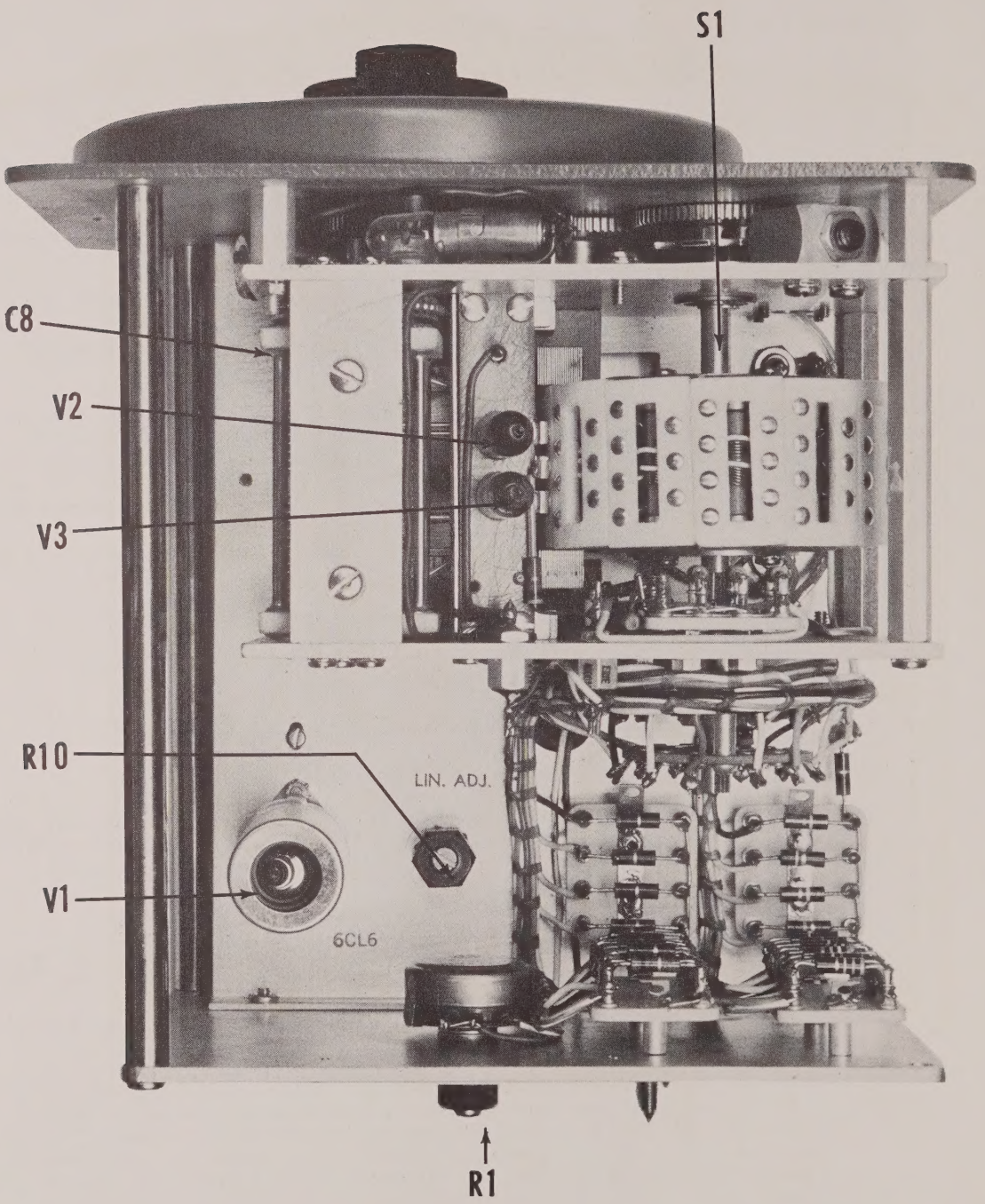



Fig. 4-3 Top view of chassis shows location of major components.

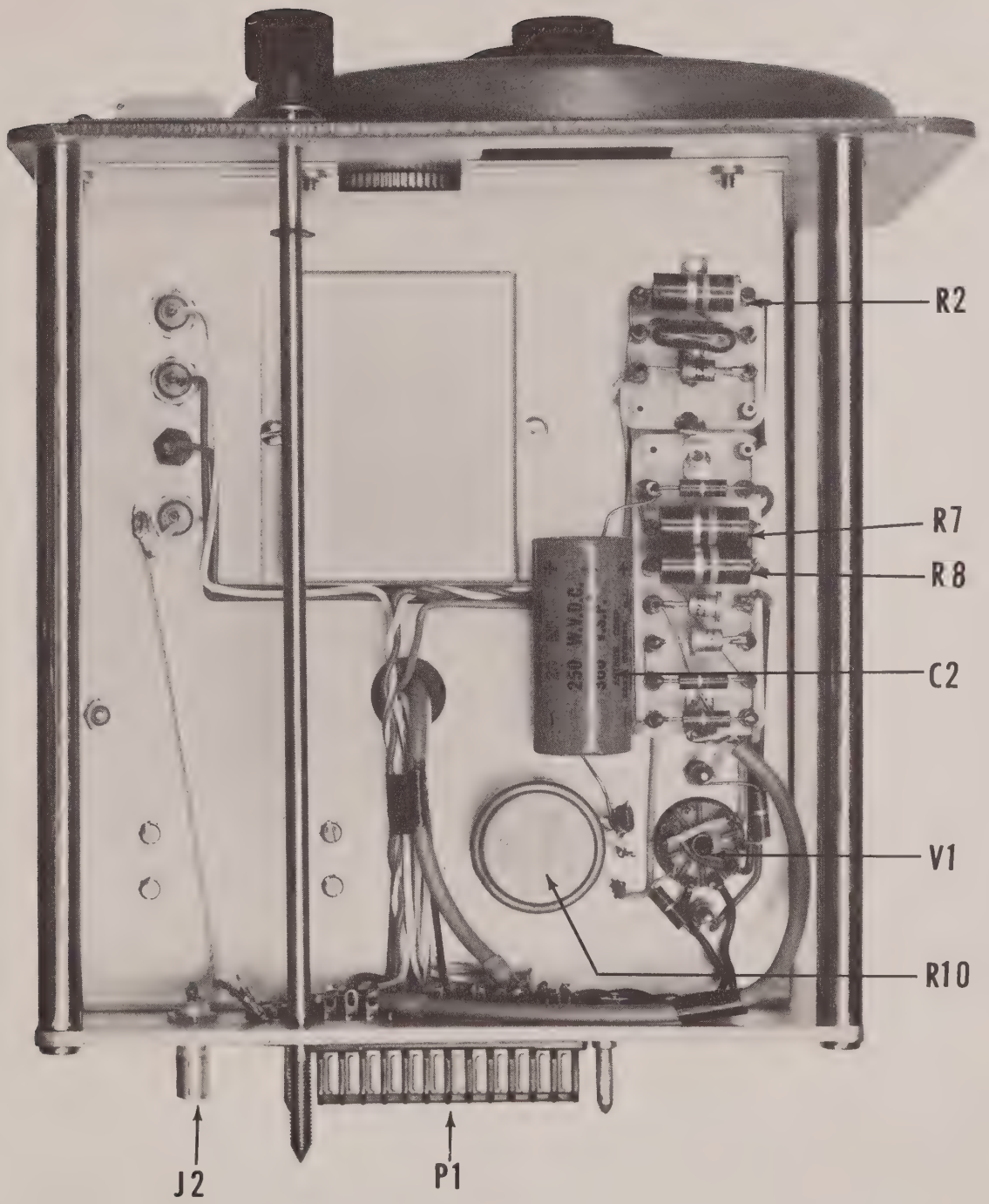



Fig. 4-4 Bottom view of chassis shows location of major components.

D. Meter Adjustment (Output Amplitude).

1. Terminate the RF Out jack on the rack unit with a 68-ohm resistor, and connect an r-f VTVM across the termination.

2. Set the Band Selector to the low band.

3. Set RF Level control fully clockwise, and all attenuation out.

4. Set Sweep Selector to CW (to remove blanking).

5. RF output as shown on the external meter should be 1 volt rms, if not, adjust the agc control on the rack to obtain 1 volt.

6. Set Meter Adjust potentiometer R-1 for 1-volt reading on the panel meter.

7. Set RF Level control fully ccw, panel meter should read 0.5 volt, indicating r-f output attenuated 6 db. If not, readjust 6 DB Adj control on rack.

Check the remaining bands using the procedure described in paragraphs C and D. Check for 1 volt rms output on each band. Low output on all bands probably indicates trouble in the push-pull oscillator (See Trouble-Shooting Suggestions, Section 4-2). Check flatness of output on all bands, which should be ±0.5 db. It is important that the detector used has flat response across the frequency range of the sweep head in use (See Fig. 4-2, detector). Flatness depends on the agc circuits functioning properly; check adjustment of AGC and 6 DB Adjust controls and note that the agc takes hold as the AGC Adj control is varied.

## SECTION V, LISTING OF REPLACEABLE PARTS

### 5-1 INTRODUCTION.

To maintain new-instrument performance when repairs are made, use only exact replacement parts, which are obtainable from Kay Electric Company. Reference the instrument type, serial number and circuit symbol number when ordering replacement parts.

### 5-2 LISTING OF REPLACEABLE PARTS, P-860E

| DWG. SYMBOL NO. | DESCRIPTION |
|---|---|
| | **CAPACITORS:** (All capacitors in uuf, 500 volts, unless otherwise indicated.) |
| C1 | 0.22uf, 50V, Mylar |
| C2 | 20uf, 250V, electrolytic |
| C3 & C4 | 6.8, ceramic, tubular |
| C5 & C6 | 0.001uf, 75V, ceramic disc |
| C7 | 1.5-8, variable, air |
| C8 | 5-45, variable, air |
| C9 | Factory selected |
| C10 & C11 | 0.02uf, ceramic disc |
| C12 thru C17 | Factory selected |
| C18 | 0.002uf, ceramic disc |
| C19 | 1000, ceramic, tubular |
| C20 | 0.002uf, ceramic disc |
| C21 | 4000, ceramic feed thru |
| C22 | 1000, ceramic feed thru |
| C23 | Not used |
| C24 & C25 | 4000, ceramic feed thru |
| D1 & D2 | Diode, Zener, 1N1514 |
| D3 | " " 1N1510 |
| D4 & D5 | " silicon, D3530 |
| I1 & I2 | Lamp, indicator, Bayonet #44 |
| J1 | Connector, UG-185/U |
| J2 | " UG-1050/U |
| | **COILS:** |
| L1 & L2 | Choke, 12 mh |
| L3 | Saturable, reactor |
| L4 | Special, 2-3.5 mc |
| L5 | " 3.5-6 mc |
| L6 | " 6-11 mc |
| L7 | " 11-20 mc |
| L8 | " 20-35 mc |
| L9 | " 35-50 mc |
| L10 | " 50-70 mc |
| L11 | " 70-90 mc |
| L12 | " 90-115 mc |
| L13 | " 115-140 mc |
| L14 | " 140-172 mc |
| L15 | " 172-220 mc |
| P1 | Connector, male, 24 contacts |

| DWG. SYMBOL NO. | DESCRIPTION |
|---|---|
| | **RESISTORS:** (Unless otherwise specified, all resistors are fixed, composition, 1/2 watt, 10% tolerance.) |
| R1 | 25K, 2 watt pot, variable |
| R2 | 47K, 2 watt |
| R3 thru R5 | 220 |
| R6 | 1K |
| R7 | 10K, 2 watt |
| R8 | 22K, 2 watt |
| R9 | 680 |
| R10 | 2K, 2 watt pot, variable |
| R11 thru R34 | Factory selected |
| R35 | 1.5M |
| R36 | Factory selected |
| R37 & R38 | 15K, ½ watt |
| R39 & R40 | 10, ½ watt |
| R41 & R42 | Factory selected |
| R43 | 10, ½ watt |
| R44 | Factory selected |
| R45 | 10, ½ watt |
| R46 & R47 | Factory selected |
| R48 | 330 |
| R49 | 300, ½ watt, 5% tolerance |
| R50 | 100, ½ watt |
| R51 | Factory selected |
| R52 | 180 |
| R53 | 330 |
| R54 | 1K |
| R55 | 47K |
| R56 | 2.2K |
| S1 | Switch, rotary, turret, 12 pos. |
| V1 | Tube, electron, 6CL6 |
| V2 & V3 | Tube, electron 5718 |

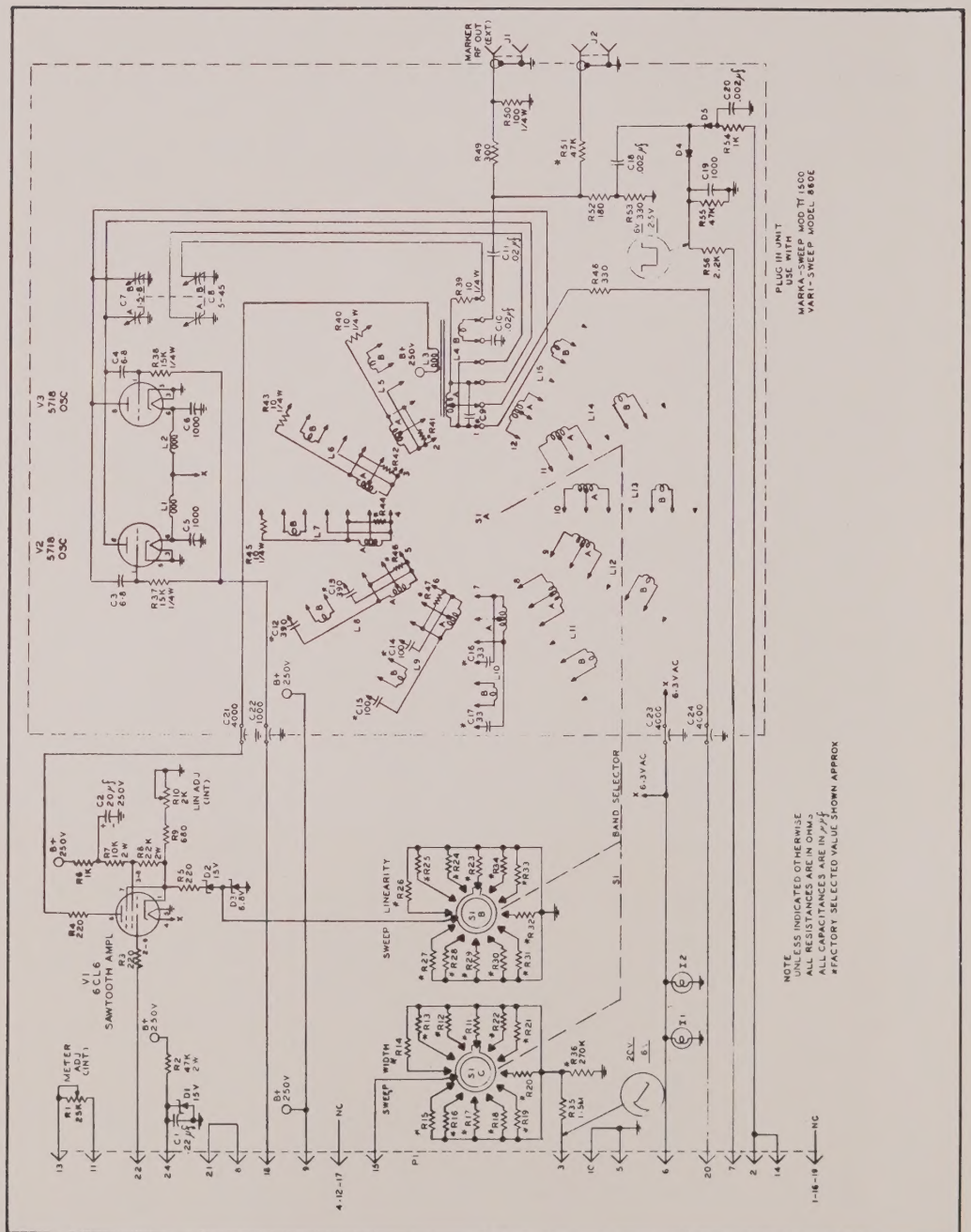
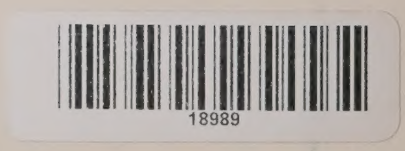



Fig. 5-1, SCHEMATIC, P-860E, C-8479A


18989